IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re:	Jonathan R. Coppeta	Confirmation No:	2283
Serial No:	10/007,502	Group:	1765
Filed:	November 8, 2001	Examiner:	Ahmed, Shamim
For:	Method for Fabricating Micro Optical Elements Using CMP		
Customer No.:	25263		
Attorney Docket No.	1099us		

APPELLANT'S BRIEF

VIA FACSIMILE: **571-273-8300**
Mail Stop Appeal Brief- Patents
Commissioner for Patents
P.O. Box 1450,
Alexandria, Virginia 22313-1450

Sir:

This is the Applicants' appeal from the final Office Action, mailed April 12, 2005 (Paper No. 20050406) and is also responsive to the Notice of Non-Compliant Appeal Brief dated July 21, 2006.

Real Party in Interest

Axsun Technologies, Inc. is the real party in interest.

Related Appeals and Interferences

There are no related appeals or interferences.

Status of Claims

Claims 1-20 have been rejected and the rejections thereof are being hereby appealed.

Status of Amendments

All amendments have been entered. There were no post final amendments or proposed amendments.

Summary of Claimed Subject Matter

The present invention of claims 1 and 16 are directed to a method for fabricating micro-optical elements such as lenses or mirrors. It covers a polishing process to convert binary etched structures, for example, to the optically curved surfaces characteristic of optical elements.

Claims 1 and 16 require forming topographic features on a surface of an optical element substrate. This is shown in more detail in Figs. 1A-1C and the specification at pages 4-5. An embodiment of the process starts with the formation of blind holes 114 into a substrate 100, as set forth in claims 2 and 16. These blind holes 114 have mesa profiles *i.e.*, they have vertical side walls and flat bottoms, as required by claim 3. As required by claim 18, sidewalls of the topographic features extend substantially orthogonally to the surface of the substrate, which is also shown in Figs. 1B and 3.

As required by claim 6, in one embodiment, the topographic features are formed in an etching process to the depth of a material layer. This is shown in Fig. 5A, in which the etch is through surface layer 125 to the surface of substrate 100. See specification at pages 6-7.

Claims 1 and 16 also require mechanically polishing the surface of the substrate to modify the features to produce curved optical surfaces on the optical element substrate. This shown in the modification of the substrate between Figs 1B and 1C, for example, in which the substrate 100 is exposed to a chemical-mechanical polishing (CMP) process. This has the effect of smoothing out the surface of the substrate 100 to thereby form, in one case, concave, optically curved surfaces 118.

Fig. 3 was generated by a profilometer. It illustrates the starting mesa, vertical sidewall profile 114 and the final, measured profile 118. Notice how the mesa profile is

smoothed to form the curved optical surface even for extremely small micro-optical components.

Claims 1 and 16 further require dicing the substrate into the optical elements. As illustrated in Fig. 4, many of these optical elements 118 can be formed on a surface 116 of the substrate 100. In a dicing process, scribe or saw lanes 122 are defined in the substrate as described in the specification at page 6. Specifically, in the illustrated embodiment, the orthogonal scribe or saw lanes 122 enable the separation of a two-dimensional array of optical elements into discrete optical elements as required by claim 17.

Claim 16 also requires "coating the optical element substrate with a reflective coating." When making mirrors optical elements, a reflective coating 150 is preferably applied.

Alternatively in the context of concave or convex lenses, an anti-reflective coating is usually applied.

Figs. 5A-5C show an alternative embodiment where the blind holes are made in a process in which an etch is provided down to a material interface layer between layers 125 and 101. This is used to well-control the depth of the blind holes, in a repeatable process.

Grounds of Rejection to be Reviewed on Appeal

Whether claims 17-20 failed to comply with the written description requirement under 3535 U.S.C. §112, first paragraph.

Whether claims 1-9, 11-15, 17, and 18 are unpatentable under 35 U.S.C. §103(a) as being obvious over U.S. Patent No. 4,524,127 to Kane in view of U.S. Patent No. 5,824,236 to Hawkins *et al.* and in further view of U.S. Patent No. 5,500,869 to Yoshida, *et al.*

Whether claims 10, 16, 19 and 20 are obvious and unpatentable under 35 U.S.C. §103(a) as being unpatentable over the Kane, Hawkins *et al.*, and Yoshida *et al.* patents in further view of U.S. Patent No. 4,451,119 to Meyers, *et al.*

Argument

Claim 1 is non obvious:

Claim 1 is directed to a method for fabricating optical elements including forming topographic features on the surface of the substrates, mechanically polishing the surface of that substrate to modify the features to produce optically curved surfaces, and then dicing the substrate into the optical elements.

The claimed process is patentably distinguishable over the applied references, because none of the references shows or suggests mechanically polishing the surface of the substrate to produce curved optical surfaces as claimed. This is the critical component on which the present invention is based, distinguishing it from the applied references.

While the Kane patent (primary reference) does show the formation of topographic features, V-grooves. It differs from the present claimed invention in that it teaches the use of chemical polishing, *i.e.,* a chemical etching process, to create the smooth optical surfaces, see Kane patent at column 1, lines 45-52, and not the claimed mechanical polishing. This defect in the Kane patent is conceded in the pending Office Action.

The Hawkins *et al.* patent was cited for disclosing mechanical polishing. See Hawkins patent at column 8, lines 18-35. The cited portion of the Hawkins *et al.* patent merely suggests that polishing can be used to planarize or produce flat surfaces. See reference 130A of Fig. 5A of the Hawkins *et al.* patent. This is the classical application of wafer polishing—to flatten and smooth a wafer surface before or after a deposition process. In contradistinction, there is no teaching to mechanically polish to produce curved optical surfaces on the optical element substrate, as claimed.

In more detail, in the past, the following portion of column 8 of Hawkins has been cited for the proposition that the references suggest the claimed invention:

> tive index higher than that of the dielectric layer **100**. The lens material **130** is preferably chosen from the group silicon nitride, titanium oxide, and tantalum oxide, and can be deposited by vacuum evaporation or by application and densification of sol-gels. The top of the coating of the lens material **130** is irregularly formed at this stage, as depicted in FIG. **5D**. Referring now to FIG. **5E**, the lens material **130** is then planarized optically flat to form optically flat lens surfaces **130***a*, preferably by chemical mechanical polishing, to the extent that the lens material **130** is removed from the optically flat surface **100***a* of the dielectric layer **100** in regions where there were no depressions **120***a*. Because the depressions **120***a* of FIG. **5C** are substantially contiguous, the remaining portions of the original optically flat surface **100***a* can be removed, either by isotropic etching or by chemical mechanical polishing to a slight extent, to form an optically flat repolished surface **100***b* of the dielectric layer **100** in its place. The optically flat lens surfaces **130***a* of the

If anything, this portion of Hawkins supports Applicants' position, however. Simply, it was known to use mechanical polishing to produce flat, planarized surfaces—in fact, this is the classic application for CMP (chemical-mechanical-polishing) machines used throughout the semiconductor industry. <u>However, was not obvious from the references to use mechanical polishing to produce optically curved surfaces, as claimed.</u>

In short, none of the applied references shows or suggests mechanically polishing a surface to convert the topographic features to the curved optical surfaces. The Kane patent teaches that the etching should be chemical. The Hawkins patent teaches mechanical polishing should be used to planarize, nothing more.

Claim 16 is non obvious:

In a similar vein, claim 16 requires mechanically polishing the surface of the substrate to modify the blind holes to produce curved, concave optical surfaces on the optical element substrate, followed by a reflective coating. None of the applied teaches the combination of mechanical polishing with reflective coating in order to produce

reflective micro-optical elements as claimed. Further, none provides for such a process for fabricating concave mirrors.

Claim 3 is further non obvious:

Claim 3 further requires that the step of forming the topographic features comprises forming blind holes having mesa profiles. In contradistinction, the Kane patent, which is cited for this feature, only describes the formation of the V grooves. See reference numeral 14 in Fig. 4 of the Kane patent. In short, none of the applied references teaches to start with mesa profile topographic features before a mechanical polishing step.

The advantage of mesas is that such surface features can be relatively easily produced in a ubiquitous and well-characterized reactive ion etch, for example. The prior art V grooves 14 of Kane are formed by an anisotropic etch that typically must be performed only in a timed process, that can be very process dependent.

Claim 6 is further non obvious:

Claim 6 requires that the formation of the topographic features comprises etching blind holes into the substrate to the depth of a material layer. In contradistinction, the Kane patent only suggests the use of a timed anisotropic etch. See Kane patent at col. 2, line 48, *et seq*.

Claim 17 is further non obvious:

None of the applied references shows or suggests the dicing in two directions to separate a two-dimensional array of optical elements into discrete optical elements. The Yoshida, *et al.* patent, cited for this feature, merely shows the dicing of submounts.

Claim 18 is further non obvious:

Claim 18 further distinguishes the etching process from that disclosed in the Kane patent. The Kane patent shows the formation of V grooves in an anisotropic silicon etch.

In contradistinction, claim 18 requires the etching of sidewalls that are substantially orthogonal to the surface of the substrate. None of the applied references shows the formation of these types of topographic features prior to a mechanical polishing step to form the claimed curved optical surfaces.

Finally, claims 17-20 satisfy the written description requirement:

Claims 17 and 19 require the step of dicing in two directions to separate a two-dimensional array of optical elements into discrete optical elements. Fig. 4 shows a two-dimensional array of optical elements 115. Scribe or saw lanes 122 extend in two directions.

Claims 18 and 20 satisfy the written description requirement. Specifically, as shown in Fig. 1 and Fig. 3, the sidewalls of the topographic features 114 extend substantially orthogonally to the substrate surface 116 as claimed.

For the foregoing reasons, Applicants believe that the pending rejections should be withdrawn, and that the present application should be passed to issue. Should any questions arise, please contact the undersigned.

Respectfully submitted,

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Claims Appendix

1. (Previously presented) A method for fabricating micro-optical elements, comprising:

forming topographic features on a surface of an optical element substrate;

mechanically polishing the surface of the substrate to modify the features to produce curved optical surfaces on the optical element substrate; and

dicing the substrate into the optical elements.

2. (Original) A method as claimed in claim 1, wherein the step of forming the topographic features comprises forming blind holes into the substrate

3. (Original) A method as claimed in claim 1, wherein the step of forming the topographic features comprises forming blind holes, having mesa profiles, into the substrate.

4. (Original) A method as claimed in claim 1, wherein the step of forming the topographic features comprises forming a feature projecting from the substrate.

5. (Original) A method as claimed in claim 1, wherein the step of forming the topographic features comprises forming mesas in the substrate.

6. (Previously presented) A method as claimed in claim 1, wherein the step of forming the topographic features comprises etching blind holes into the substrate to a depth of a material layer.

7. (Original) A method as claimed in claim 1, wherein the step of forming the topographic features comprises etching blind holes into the substrate in a timed process.

8. (Original) A method as claimed in claim 1, wherein the step of polishing the surface comprises performing chemical mechanical polishing of the surface.

9. (Original) A method as claimed in claim 1, further comprising optically coating the surface after the polishing step.

10. (Original) A method as claimed in claim 9, wherein the step of optically coating the surface comprises depositing a highly reflective layer on the surface.

11. (Original) A method as claimed in claim 9, wherein the step of optically coating the surface comprises depositing an antireflective layer on the surface.

12. (Original) A method as claimed in claim 1, further comprising optically coating the surface after the polishing step and before the dicing step.

13. (Original) A method as claimed in claim 1, wherein the step of dicing the substrate comprises sawing the substrate.

14. (Original) A method as claimed in claim 1, wherein the step of dicing the substrate comprises cleaving the substrate.

15. (Previously presented) A method as claimed in claim 1, wherein the step of forming the topographic features on the surface of the optical element substrate comprises forming the features on silicon or gallium phosphide wafer material.

16. (Previously presented) A method for fabricating reflective micro-optical elements with a concave curvature, comprising:

forming blind holes into a surface of an optical element substrate;

mechanically polishing the surface of the substrate to modify the blind holes to produce curved, concave optical surfaces on the optical element substrate;

coating the optical element substrate with a reflective coating; and

dicing the substrate into the concave optical elements.

17. (Previously presented) A method as claimed in Claim 1, wherein the step of dicing is performed in two directions to thereby separate a two dimensional array of optical elements into discrete optical elements.

18. (Previously presented) A method as claimed in Claim 1, wherein sidewalls of the topographic features extend substantially orthogonally to the surface of the substrate.

19. (Previously presented) A method as claimed in Claim 16, wherein the step of dicing is performed in two directions to thereby separate a two dimensional array of optical elements into discrete concave optical elements.

20. (Previously presented) A method as claimed in Claim 16, wherein the sidewalls of the blind holes are substantially orthogonal to the surface of the substrate.

Evidence Appendix

None

Related proceedings appendix

None